OKA-C046
DWM

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)
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Takashi MIIDA	)
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Serial No. 09/774,667	) Examiner: G. Selby
	)
Filed: February 1, 2001	) Group Art Unit: 2615
	)
For: METHOD OF STORING OPTICALLY GENERATED CHARGES BY OPTICAL SIGNAL IN SOLID STATE IMAGING DEVICE	) January 5, 2005

AMENDMENT AND RESPONSE TO OFFICE ACTION OF OCTOBER 5, 2004

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the office action dated October 5, 2004, please make the following amendments in the above-identified application.

Amendment to the Title:

Change the tittle to: —METHOD OF PREVENTING TRANSFER AND STORAGE OF NON-OPTICALLY GENERATED CHARGES IN SOLID STATE IMAGING DEVICE—

Amendments to the claims:

1 (currently amended). A method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device comprising the steps of:

(i) preparing the solid state imaging device comprising a unit pixel including

(a) a photo diode ~~formed in a well region~~ provided with

(1) a semiconductor layer of a first conductivity type, and

(2) an impurity region of a second conductivity type formed on a surface layer of the semiconductor layer so that the photo diode has a buried structure, and

(b) a field effect transistor for optical signal detection formed in the ~~well region~~ semiconductor layer adjacently to the photo diode, ~~comprising~~ provided with

(1) a source region of the second conductivity type formed on the semiconductor layer,

(2) a drain region of the second conductivity type formed on the semiconductor layer and connected to the impurity region,

(3) a channel region formed on the surface layer of the ~~well region~~ semiconductor layer between a source region and a drain region,

(4) a gate electrode formed covering the entire channel region by interpolating a gate insulating film, and

[[(2)]] (5) a carrier pocket ~~being~~ of a high-density buried layer of the first conductivity type provided in the ~~well region~~ semiconductor layer under the channel region ~~in the vicinity of the source region~~;

(ii) generating optically generated charges in the photo diode by light irradiation;

(iii) transferring the optically generated charges to the carrier pocket while accumulating movable charges of the same conductivity type as that of the source region over the entire channel region by means of a potential of the gate electrode; and

(iv) storing the optically generated charges in the carrier pocket while accumulating movable charges of the same conductivity type as that of the source region over the entire channel region by means of a potential of the gate electrode.

2 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 1, wherein the field effect transistor for optical signal detection is a depletion type.

3 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 1, wherein movable charges of the same conductivity type as that of the source region are accumulated over an entire surface layer of the ~~well region~~ semiconductor layer including the channel region at least in the steps of transferring and storing.

4 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 1, wherein a current is

flowed to the field effect transistor for optical signal detection to read out a change in a threshold voltage after a period when the optically generated charges are transferred to the carrier pocket to be stored therein.

5 (currently amended). A method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device comprising the steps of:

(i) preparing the solid state imaging device comprising a unit pixel including

(a) a photo diode provided with

(1) a first ~~well region~~ semiconductor layer of a first conductivity type, and

(2) an impurity region of a second conductivity type formed on ~~the first well region~~ a surface of the first semiconductor layer so that the photo diode has a buried structure, and

(b) a field effect transistor for optical signal detection placed adjacently to the photo diode, provided with

(1) a second ~~well region~~ semiconductor layer of the first conductivity type connected to the first ~~well region~~ semiconductor layer,

(2) a source region of the second conductivity type formed on the second ~~well region~~ semiconductor layer,

(3) a drain region of the second conductivity type formed on the second ~~well region~~ semiconductor layer and connected to the impurity region,

(4) a channel region formed on a surface layer of the second ~~well region~~ semiconductor layer between the source region and the drain region,

(5) a channel doped layer of the second conductivity type formed on the channel region,

(6) a gate electrode formed ~~on the~~ covering the entire channel region by interpolating a gate insulating film, and

(7) a carrier pocket of the first conductivity type being provided in the second ~~well region~~ semiconductor layer under the channel region in the vicinity of a source region;

(ii) generating optically generated charges in the photo diode by light irradiation;

(iii) transferring the optically generated charges to the carrier pocket while accumulating movable charges of the second conductivity type over the entire channel region ~~upon holding~~ be means of a potential of the gate electrode~~ such that the channel region comes into an accumulation state where the channel region is filled with the movable charges~~; and

(iv) storing the optically generated charges in the carrier pocket while accumulating movable charges of the second conductivity type over the entire channel region ~~upon holding~~ by means of a potential of the gate electrode~~ such that the channel region comes into an accumulation state where the channel region is filled with the movable charges~~.

6 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 5, wherein the field effect transistor for optical signal detection is a depletion type.

7 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 5, wherein movable charges of the second conductivity type are accumulated over an entire surface layer of the first and second ~~well regions~~ semiconductor layers including the channel region at least in the steps of transferring and storing.

8 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 5, wherein a current is flowed to the field effect transistor for optical signal detection to read out change in a threshold voltage after a period when the optically generated charges are transferred to the carrier pocket to be stored therein.

9 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 5, further comprising a plurality of the pixels arranged in rows and columns, wherein the optical signals are stored in the respective pixels by supplying different scanning signals to the mutually connected gate electrodes of the field effect transistors arrayed in the same row, the mutually connected drain regions of the field effect transistors arrayed in the same row, and the mutually connected source regions of the field effect transistors arrayed in the same column.

10 (currently amended). The method of storing ~~optically generated~~ charges generated by an optical signal in a solid state imaging device according to claim 9, wherein the storing of the optical signals into the respective pixels and the reading-out of the stored optical signals are controlled by a vertical scanning signal driving scanning circuit for supplying a scanning signal to the gate electrodes in the raw, a drain voltage driving scanning circuit for supplying a drain voltage to the drain regions in the raw, a signal output circuit for storing voltages of the source regions in the column and further outputting an optical signal corresponding to the voltage of the each source region, and a horizontal scanning signal input scanning circuit for supplying a scanning signal for controlling a timing of reading out the optical signal.

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Amendments to the drawing figures:

In Fig. 1, the label "PRIOR ART" is added. A replacement sheet is enclosed.

REMARKS

The title is changed as required by the examiner.

Fig. 1 is amended by adding the label "PRIOR ART".

Reconsideration of claims 1-10 in view of the rejection under 35 U.S.C. §102(b) in view of JP 11-195778 is requested inasmuch as the cited prior art fails to teach or suggest the particular combination of steps forming the method of storing charges generated by an optical signal in a solid state imaging device as set forth in the rejected claims. The claims are deemed allowable particularly for reciting, among other things, transferring the optically generated charges to the carrier pocket <u>while accumulating movable charges of the second conductivity type over the entire channel region by means of a potential of the gate electrode</u>, and storing the optically generated charges in the carrier pocket while <u>accumulating movable charges of the second conductivity type over the entire channel region by means of a potential of the gate electrode</u>. As noted in the specification on page 2, line 24 through page 4, line 15, the prior art (JP 2,935,492 corresponds to the JP 11-195778 – see also corresponding US Patent 6,051,857) applies a gate potential during the storing period of the optically generated charges to deplete (i.e., cutoff) the channel region. Thus non-optically generated carriers or charges of the same conductivity type as the optically generated charges, such as charges generated at the interface of the gate insulating film and the channel region, can be generated and migrate to the carrier pocket thus causing a bright luminance line or a so-called white scratch or other defect or deficiency in the stored image. The present invention, by providing

a gate potential which accumulates charges of the opposite conductivity type in the channel region prevents the migration of non-optically generated charges or carriers to the carrier pocket. For the example of the storage of p-type carriers in Fig. 2 voltage Vpg (VSCAN) is greater than the voltages Vpd and Vps during the portion A of the storing period which results in electrons accumulating in the channel region, see Fig. 4A, preventing migration of holes from the interface between the gate insulation 18, Fig. 8, and channel region 15c to the carrier pocket 25.

In contrast as noted in Fig. 1 of the present application, the prior art applies a cutoff voltage to the gate electrode, for example for p-type optically generated carriers a voltage Vpg (VSCAN) which is less than the drain and source voltages Vpd and Vps to deplete the channel region of electrons and thus cutoff conduction through the channel. The office action erroneously cites Figure 3 and paragraphs 43- 45 of JP 11-195778 as disclosing the accumulating of movable charges of the same conductivity type (such as n-type) in the channel region; Fig. 4A and column 9 , lines 8-47, correspond to Figure 3 and paragraphs 43-45 of US 6,051,857. At column 9, line 31, US 6,051,857 states that the channel region is normally depleted, i.e., does not accumulate any movable charges. Figure 13 of JP 11-195778 which corresponds to Fig. 7B of US 6,051,857 shows the gate voltage VSCAN as being less than the drain voltage VDD (the source voltage is not shown but would have to be greater than the gate voltage VSCAN to avoid conduction through the channel region).

Thus it is clear that JP 11-195778 discloses the absence and not the accumulation of movable charges in the channel region during the storage period and the rejection based upon JP 11-195778 must be withdrawn.

The other cited references U.S. Patents 5,317,174 (Hynecek) and 5,430,312 (Yamada), JP8-236741 and EP 0 978 878 have been reviewed but are deemed not to be particularly pertinent to the present claims.

The application is now believed to be in condition for allowance and such favorable action is requeste.

Respectfully submitted,

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FIG. 1

(PRIOR ART)